

EA 87-02

IN THE MATTER of the Environmental Assessment Act (R.S.O. 1980, c. 140) as amended; and

IN THE MATTER of a hearing before the Environmental Assessment Board regarding a Class Environmental Assessment for Timber Management on Crown Lands in Ontario.

WITNESS STATEMENT No. 3

ECOLOGICAL AND TIMBER MANAGEMENT ISSUES
RELATING TO REGENERATION

PREPARED BY

GEORGE MAREK R.P.F.

FILED ON BEHALF OF
FORESTS FOR TOMORROW
a coalition of

The Botany Conservation Group
of the University of Toronto

The Federation of Ontario
Naturalists

The Sierra Club of Ontario

The Temiskaming Environmental
Action Committee

The Wildlands League, an Ontario
Chapter of the Canadian Parks

Earth Sciences Library



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

<https://archive.org/details/31761056888415>

Something in our transfer of knowledge
is wrong because the goals in forestry
are wrong.

Dusan Mlinsek, President of
the International Union of
Forest Research Organizations

A paper presented at the International
Forest Congress, Quebec City, 1984

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY	i
2. INTRODUCTION	1
3. DEFINITIONS	6
4. WILDFIRE AND THE NATURAL RENEWAL OF THE BOREAL FOREST	8
4.1 Regeneration of Burned-Over Sites to Primary Species	11
4.2 Misconceptions Regarding the Similarities between Wildfires in Standing Timber and Clearcutting	12
4.3 Regeneration of Cut-Over Lands	15
5. BLACK SPRUCE SILVICULTURE	18
5.1 Reproductive Ability of Black Spruce	18
5.2 Nitrogen Cycle	18
5.3 Environmental Conditions of Large Cutovers	19
5.4 The Effect of Moisture on Black Spruce Forests and Sites	20
5.5 Vegetation Response to Changing Moisture Conditions	22
5.6 Seedbed - Microsite Considerations for Black Spruce	26
5.7 Forest Ecosystem Classification	28

6.	BLACK SPRUCE FOREST RENEWAL	30
6.1	Results of Cut-over Studies in the Lake Nipigon Area	30
6.2	Tree Planting in the Boreal Forest	36
6.3	Problems of Seedling Quality	44
6.4	Neglect of White Spruce Seedling Production	47
7.	OTHER REGENERATION TECHNIQUES AVAILABLE	49
7.1	Direct Seeding as a Regenerating Technique	49
7.2	Site Preparation in the Boreal Forest	51
7.3	Natural Regeneration of Black Spruce on Large Area Clearcuts	52
8.	ISSUES IN THE USE OF MODIFIED HARVEST, FIRE, AND STAND TENDING	55
8.1	Modified Harvesting of Stands	55
8.2	Tending of Regeneration	62
8.3	The Use of Fire as a Silvicultural Tool	65
8.4	Multiple Use of Forest Lands	66
8.5	Integration of Logging with Silviculture	72
8.6	Intensification of Timber Production	75
9.	PROBLEMS OF INSTABILITY IN SECOND GROWTH AND OLD VIRGIN TIMBER	76
10.	CONCLUSION	81

1. EXECUTIVE SUMMARY

1

This Witness Statement was prepared in order to present evidence to the Environmental Assessment Board regarding renewal successes and failures on areas harvested since the establishment of Forest Management Agreements. In order to present the broad picture of varying conditions, forest sites, and dynamics, some generalizations have been necessary.

2

In the preparation of this Witness Statement, the witness has reviewed relevant transcripts, and Exhibits, including Witness Statements, submitted to the Board.

3

The Introduction to the Witness Statement states the finding of the Witness that on many sites, the present practices of large area clearcutting followed by tree planting or leaving the cutover sites without any silvicultural treatments, are not adequate prescriptions to maintain the productivity and integrity of black spruce forests. In contrast, small area clearcut management is a preferable treatment and

biologically sound method of forestry.

In North America, the productive role of forestry has been emphasized to the detriment of the protective role, with the result that the ecological stability of our forests is threatened.

Pages 1 to 5

4

Definitions of the terms utilized in the report are provided.

Pages 6 to 7

5

Wildfire in standing timber is perhaps the most important factor influencing the dynamics of the boreal forest, and affects the multiplicity of the forest ecosystem components in many different ways, creating conditions conducive to the regeneration of coniferous species.

Pages 8 to 12

6

Clearcutting is not equivalent to fire in its effects on forest land, and often acts as a "harvesting" system for the

desired species, and then as a "silvicultural seed tree system" for undesired species. Large area clearcuts may lead to domination of the site, after harvest, by species which do not similarly capture sites after fire.

Pages 12 to 15

7

The uniqueness of black spruce is based on its role in and adaptability to the northern landscape and climate. It is not a pioneer species like jack pine. Its management should be guided by the natural processes to which the species has adapted, and ecologically-sound management of black spruce on the majority of sites cannot be done by the removal of all trees from the entire landscape.

Pages 16 to 18

8

The moderate conditions necessary for black spruce regeneration are not prevalent on large area clearcuts, and processes counter-productive to regeneration may occur.

Pages 19 to 21

9

Changes in moisture conditions after timber harvesting frequently have significant impacts on boreal forest lands, and lead to changes in vegetation of the site. Poor aeration associated with high water levels is detrimental to black spruce growth, and has been found to occur on some boreal forest sites after harvest. The expansion of sphagnum at the expense of pleurozium mosses is an indicator of a water problem, and where it occurs, seedlings established on sphagnum show poor growth.

Pages 21 to 26

10

Microsite conditions after harvest are important for the successful regeneration of black spruce, and the tolerance range of seedlings may be exceeded by the effects of harvesting activity, requiring ameliorative treatment.

Pages 26 to 28

11

The Forest Ecosystem Classification field guides are worthwhile documents but their usefulness is limited since they do not consider the successional trends after harvesting and the resulting impacts on the ecosystem.

Pages 28 to 29

12

Studies of regeneration on cutovers in the Nipigon District have indicated nutrient losses from harvest, and the full-tree logging technique gives cause for concern regarding regeneration and long term productivity on some sites. Experience gained from the establishment of large areas of black spruce plantations indicates that to produce artificial, even-aged pure spruce stands, one needs justifiable expectations of considerably higher yields; understanding of forest stability and how to ensure it; proper spacing of planted trees; resources for continuous tending; and knowledge and strategies for dealing with risks.

Pages 30 to 38

13

The reliance on conventional large area clearcutting followed by tree planting for regeneration causes obvious problems in various areas of Northern Ontario. These problems include seedling failure in low-lying poorly drained areas; adverse impacts on some sites from logging equipment; logging debris and its interference with planting; negative effects of scarification; encroachment of logging on marginal sites; and

problems with jack pine plantations.

Pages 38 to 44

14

The rapid expansion of the use of artificial regeneration and consequent expansion of the seedling nursery industry have resulted in problems of seedling quality. Production of white spruce seedlings and regeneration of white spruce has been neglected.

Pages 44 to 48

15

The use of direct seeding of jack pine may be described as one of the successful techniques for the management of jack pine sites in the boreal forest. However, direct seeding of black spruce, though nearly always successful after natural disturbance, has usually been a failure on large area clearcuts.

Pages 49 to 51

16

Site preparation techniques, particularly for large area treatments, must become more innovative and consider changes

in the site from removal of the trees, if optimal results are to be achieved.

Pages 51 to 52

17

Natural regeneration of black spruce on untreated large area clearcuts has led to poor quality second growth forests, in many areas.

Pages 52 to 54

18

Modified harvesting, including block, strip, and shelterwood cutting and group seed tree techniques, collectively referred to as small area clearcutting, provide environmental and production benefits. The effects of the standing timber on the micro-environment, and its moderating effect on wind, air temperature, radiation, humidity, and precipitation are of vital importance for successful regeneration. Given the conditions of the boreal forest of Northern Ontario, which is composed mainly of a mixture of large areas of shallow, rocky sites and deep organic sites, small area clearcut management should be a major technique.

Pages 55 to 58

19

The claims that increased road costs to the forest industry and increased blowdown are associated with small area clearcutting have little credibility given government funding for roads and a recent study of wind-throw after strip-cutting.

Pages 58 to 60

20

Benefits of modified harvesting include lower regeneration costs and the ability to adjust timber production to facilitate other forest uses.

Pages 60 to 62

21

The tending of regeneration is an important task, and many problems associated with chemical use can be observed in the boreal forest. The widespread problem of aspen competition and its seeding-in is directly related to the large areas of clearcuts, and most forest managers appear poorly equipped to deal with this long-term problem. The spraying of public roads and rights-of-way is unacceptable.

Pages 62 to 65

22

The use of fire as a silvicultural tool should be limited to certain sites, and should change the humus of the forest floor to a new, active condition if the regeneration of spruces is to succeed.

Pages 65 to 66

23

The "multiple use" concept, as utilized by the OMNR, is not satisfying the majority of forest users, and has largely evolved into "sequential use", with little consideration that timber harvesting may destroy the possibilities of real multiple use. The necessary "patterns in the forest" (referred to in the Overheads used in the testimony Dr. Gordon Baskerville, Exhibit 970), should be set through ground rules and prescriptions in the Timber Management Plans, starting with harvesting methods. Use of holistic management including small area clearcutting has demonstrated benefits for the accommodation of timber production and wildlife considerations.

Pages 66 to 72

24

The integration of logging and silviculture has not been

achieved through the Forest Management Agreement structure. Some additional effort is necessary initially to use small area clearcut management, and there is a lack of training for forestry graduates in these methods. The integration of logging and silviculture will only be implemented when it is fully understood and accepted as a whole.

Pages 72 to 76

25

The boreal forest consists of two types of forest: the old, virgin forest, and the new, second growth forest. The instability of both types of forest raises considerable uncertainty about the future of Ontario's wood supply, given the proliferation of hardwoods and balsam fir in cutover areas.

Pages 76 to 80

26

The creation of a new, healthy forest in boreal regions will be accomplished only if a combination of natural and artificial means of a forest renewal is practised in a ratio depending on site and stand conditions. Large area clearcut management often is a factor in creating instability for certain tree species. The ecosystem should dictate

harvesting and silvicultural prescriptions. My investigations have led me to the following conclusions:

1. Wildfire in standing timber has beneficial effects on the ecology of black spruce sites, their regeneration and ability to promote continuous productivity. These effects are not duplicated by large area clearcutting.
2. There is a necessity to improve the Forest Eco-system Classification documents to consider disturbed sites and to provide better and more practical guidelines for field forest managers.
3. Pre-cut and post-cut surveys should be done by experienced foresters and forest technicians to prevent duplication and repetition of mistakes.
4. The problem of trembling aspen as competition and its effects on the establishment of primary species must be acknowledged. This problem could be minimized by changes to harvest practices and the use of biologically-oriented silvicultural prescriptions.
5. Tree planting should be reserved for specific sites only. Frequently the sites close to roads that are suitable for planting suffer heavy damage from logging equipment.

"Normal operations" are frequently conducted without consideration of site protection. Subsequent renewal efforts therefore suffer.

6. Better and more site-specific site preparation of cutovers must be practised with a strong emphasis on biological stability.
7. There is a need to emphasize specific site protection. Small area clearcut management which answers this need should replace present harvesting strategies. This is possibly the best way to address the problems specific to many uplands and lowlands in the boreal forest.
8. The term "fragile sites" must be accepted and understood and their vulnerability considered by loggers. These sites represent a large proportion of the productive forest land base.
9. The separation of logging and silviculture still exists on most if not all logging operations. This means that the logger uses the cheapest, most convenient method of extraction and the resulting problems for renewal cannot be resolved by simply planting trees.
10. The "second growth forest," the lack of knowledge of its

dynamics, and its instability, constitute potential serious problems for long-term wood supply in Ontario.

Pages 81 to 85

George Marek will attend the hearing and give evidence regarding the subject of this Statement of Evidence.

2. INTRODUCTION

This Witness Statement was prepared in order to present evidence to the Environmental Assessment Board regarding renewal successes and failures on areas harvested since the establishment of Forest Management Agreements. Such assessment is bound to cover the whole gamut of circumstances, forest sites and their conditions across the forest regions of Northern Ontario's boreal forest. This assessment cannot be separated from the total picture of forest land dynamics. Therefore, in order to present a broader picture with some credibility, some generalizations have had to be made.

My findings have led me to state that on many sites the present practices of large area clearcutting followed by tree planting or leaving the cutover sites without any silvicultural treatments are not adequate prescriptions to maintain the productivity and integrity of black spruce forests. While artificial regeneration such as tree planting may be the only alternative on some sites, "normal operations", which often include the need for tree planting, are wasteful when all costs are included.

Small area clearcut management followed by natural regeneration from a standing seed source is a preferable treatment and biologically sound forestry. Of course, in cases where regeneration fails using this natural approach, tree planting should follow.

Forest managers who are trying to convert the productive sites of the boreal forest mixedwoods into a single species coniferous forest should be aware of the dangers of risks involved. While the early stages of tree development look promising, the later results may be disappointing.

Having spent a lifetime in forestry, I have always felt a special relationship to forest lands. Very early in my career, I encountered two distinct approaches to forest management. The first can be characterized as a combination of art and science, where understanding, protecting and conserving natural resources are all important. The second can be characterized as primarily a business and profit-making venture based on maximizing immediate returns. The second approach has predominated in North America for many decades.

Since the introduction of FMAs, a supposedly new approach to forestry, so-called "modern scientific forest management" has been popularized. Essentially, this is the application of

harvesting and renewal practices resembling agricultural manipulation to the forest landscape and the production of forest crops. The prescriptions for such undertakings usually embody short rotations, clearcutting and planting, and the use of chemicals for crop protection. Accompanying this is an expectation of higher crop yields. This is exemplified, to some degree, in the present industrial treatment of the forest.

There is really nothing new in this approach to forestry.

This philosophy and practice came from Europe where:

for some hundred years forestry has learned from its own mistakes how to develop forestry for the future.
(Mlinsek, 1984, p. 55)

However, we in North America have yet to learn how to give equal emphasis to both the protective and the productive roles of forestry. So far the emphasis has been on the latter to the detriment of the former. In fact, for the past 40-50 years in Ontario, new approaches and experiments in forest management have been practised under the aegis of "modern scientific forestry." However, these "progressive phases" emphasized the productive role in forest management and were in response to current problems and were efforts to investigate and ameliorate past mistakes only.

What about the past and present goals of forest management? The lessons that we should have learned by now from the past

are that:

- a) Traditionally, forest managers were led to believe that nature and time will heal the problems caused by forestry operations. This is naive. While I have witnessed recovery in some cases, this is not true overall.
- b) There is a difference between forestry and agriculture in terms of soil productivity and ecosystem complexity and function. In addition, agricultural crops are harvested annually and problems can be quickly identified and dealt with. This is not so in forestry, where crop rotations in the boreal forest are fifty to one hundred years.
- c) "Forestry development is real only if it is oriented to the long-term; forestry oriented to the short-term is really a special branch of forestry." (Mlinsek, 1984)
- d) Just as in agriculture, forestry is encroaching on lands which should not be developed. Such lands are not suited to timber production.
- e) "The promotion of ecological stability is the primordial mission of forest treatment: from the relative stability of the object depends the relative stability of its use." (Van Miegroet, 1979)

- f) Forestry should serve a great number of uses and a wide variety of users. There have always been serious problems in accommodating each of them.
- g) In 1983, while still in the service of the OMNR, I was asked to investigate the quality and results of silvicultural practices in North Central Ontario. My report began with the following:

In the last few decades, millions of hectares of northern boreal forests have been logged over. During my travels I have discovered many miles through silviculturally treated and untreated cutovers. Many of these areas have been left to nature's care.

The cutovers left to nature can be identified by the proliferation of balsam fir, hardwoods and brush. The cutovers treated with a very substantial investment in effort, time and money can be identified by less balsam fir, stocking of some spruce or jackpine, accompanied and frequently dominated by the omnipresent aspen and brush.
(Marek, 1983)

Did we renew the old forest or did we replace it with something else? If we did, what will the value of this second-growth forest be?

3. DEFINITIONS

The following definitions are presented to clarify usage in this report.

1. Large Area Clearcut Management

The progressive harvest of even-aged stands over a wide area. Contiguous cuts can add up to many square miles. In practice, it often disregards the biological and environmental aspects of the sites.

2. Small Area Clearcut Management

A silvicultural prescription where the harvest takes into consideration the biological and physiographic needs of the site and ecological characteristics of the species to be reproduced." (D.M. Smith)

3. Sustained Yield

The ability to sustain production of primary biological products in terms of yield and quality.

In the Crown Timber Act, R.S.O. 1980, c. 109, s.6(2),

"sustained yield" is defined as:

"the growth of timber that a forest can produce and that can be cut to achieve a continuous approximate balance between growth of timber and timber cut."

4. Site productivity

The capacity of the land to produce primary biological

products expressed as dry weight or carbon per hectare per year. (Buringh, 1987)

5. Site Degradation

Any change in physical, chemical or biological properties which reduces productivity.

6. Forest Stability

Forest stability is "the capacity to resist perturbation, or to revert to the original state after perturbation." (Van Miegroet, 1979, p. 17)

"Forest stability should be considered from three points of view: population-genetical, ecophysiological and mechanical." (Arlinsek,)

7. Silvicultural Prescription

A schedule of specific Silvicultural measures intended to achieve on a given site, a defined management objective or set of objectives. (Sutton, 1990)

4. WILDFIRE AND THE NATURAL RENEWAL OF THE BOREAL FOREST

Ecologically based forest treatment finds its inspiration in the course of natural phenomena. (Van Miegroet, 1979)

THE PLACE OF WILDFIRE

The following discussion is of wildfire in standing timber and not of wildfire or prescribed burns on cutovers.

Wildfire in standing timber is perhaps the most important factor influencing the dynamics of the boreal forest. It destroys timber, regenerates timber, and helps it grow. Although the role of fire in the virgin forest and its results have been broadly documented, the details and complexities and relationships in these results are not well understood. Generalizations are frequently made equating man-made disturbances with wildfire. This suggests that the strategies of wildfire are either unknown or misunderstood.

Before a wildfire, a boreal forest ecosystem consists of a multiplicity of components. Wildfire affects these components in many different ways. Wildfire is not just a process whereby standing timber is burned and a new generation of the primary species is established. It is a complex interplay among the various parts of the ecosystem--atmospheric, biological, geological, chemical

and physical. The boreal forest has genetically adapted over thousands of years to these major periodic disturbances, and demonstrates a remarkable resiliency to these perturbations. Indeed, the autecology of the major tree species primarily reflects such adaptations.

Periodic wildfire is when and where the ecosystem really proves itself. It is therefore of the utmost importance that forest managers and silviculturalists understand these processes and be guided by them.

An extreme period of drought is a pre-requisite for wildfire. The most susceptible stands are those which are mature or over-mature, and which have a major coniferous component. In these stands, various amounts of downed woody debris close to the forest floor must be present. This material, in combination with ericaceous plants and possibly advance growth of balsam fir, are the necessary fuel to spread the fire from the ignition point and allow it to gain momentum.

The intensity of the fire depends on the weather, topography, fuel arrangement and tree species composition. There are several types and combinations of fire: surface fire, crown fire, trunk fire, and the fire within the forest floor. Special attention should be paid to the ones which create microsites for seedbeds.

Variations in fire intensity create a mosaic of effects. Ground fires consume the thick, acidic soil humus layer usually present on coniferous sites. They also kill or damage the understorey, including ericaceous shrubs, and reduce soil acidity. The preparation of seedbeds and microsites by wildfire is a unique process. This may occur through the creation of moist pockets, the exposure of decomposing wood and tree debris and the exposure of well-decomposed organic horizons and surface mineral horizons enriched with organic matter.

Large fires are usually controlled by nature and put out by heavy rainfall. This rain soaks into the forest floor, providing plentiful moisture for germination and carrying fire-released nutrients into the upper soil horizons. This enriches the soil and reduces nutrient losses to volatilization.

The serotinous or semi-serotinous cones located at the top of jack pine and black spruce trees open immediately after fire, releasing seeds to the microsites on the forest floor. This seed dispersal may continue for several weeks or even months. However, the most vigorous dispersal is immediately after the fire, thus taking advantage of the very receptive, moist seedbeds.

4.1 Regeneration of Burned-Over Sites to Primary Species

Following wildfire, coniferous regeneration usually germinates prolifically and dominates the sites. Cases have been reported of several hundred thousand conifer seedlings per ha. germinating (Methven et.al., 1975). This can happen before the blackened surface of the site starts to dry out.

Biological activity is a key factor in maintaining site productivity. In wildfire situations biological processes are already under way as the forest floor is cooling off and a tremendous explosion of biological activity occurs. There is little known about how these processes are initiated and where the agents of this enrichment come from. While some nutrients are lost during the fire through volatilization and leaching, many nitrogen-fixing micro-organisms appear. Fungi, actinomycetes, pioneer lichens and mosses and bacteria are the early colonizers of the forest and help to stabilize the site and retain and enrich the nutrient capital of the soil. The burned standing timber has a further role in serving as antennae to intercept airborne particles, providing further enrichment of the forest floor.

These processes are difficult to understand fully and almost impossible to duplicate. However, there are important lessons to be learned. One very important one is how the primary species have worked to ensure their survival and dominance.

4.2 Misconceptions Regarding the Similarities Between Wildfires in Standing Timber and Clearcutting.

Many Timber Management Plans in the boreal forest state words to the effect of:

Clearcut harvesting has the effect of duplicating stand development, much as natural catastrophes (fire, blowdown, insect outbreaks) do, but on a more local (and controlled) scale. The softwood species of the boreal forest have become genetically adapted to survive and thrive under these seemingly abrupt changes. Harvesting attempts to duplicate these conditions. (Canadian Pacific Forest Products/Great Lakes Timber Management Plan submitted to MNR, Nipigon, 1987, p. 74)

Likewise, many industrial foresters view clearcutting as equivalent to disturbance by wildfire.

Clearcutting, the felling of all merchantable trees in a block, is a common and acceptable practice all around the world. Within the immense boreal region that comprises about 80 per cent of Canada's forested land are found a relatively small number of coniferous forests probably originated at about the same time, when a major disturbance such as an insect infestation or a fire cleared the forest.

In the wake of such an event, experts tell us, the forest begins to renew itself - to regenerate - with

aspens, birches and alders. Gradually, conifers spring up. Longer-lived than their deciduous cousins, they reach for the light they need, grow taller, and eventually form the new stand. The clearcutting option opens or "clears" the forest much as nature does, and, in addition, is more economical than selective cutting. It is the method of choice when the goal of regeneration, by planting, by natural seeding, or by a combination of both techniques, is to achieve a forest similar to the one it replaces. (Harvesting the Forest Crop, Canadian Pulp and Paper Association, 1989)

In the typical boreal forest clearcut, many low value species are left behind, some on the ground, some standing uncut. The majority of these species can reproduce by suckering, coppicing, and seeding. Thus, the primary species having been removed by clearcutting, the system itself is actually a seed tree system for the unwanted species left behind. A large area clearcut is a "harvesting" system for the desired species. The same large area clearcut is a "silvicultural seed tree system" for undesired species.

Large area clearcuts create open landscapes in which plant species not generally found on certain sites are able to spread and take over the entire landscape. Thus, species which never proliferate immediately after wildfire under natural circumstances, may dominate the site after large area clearcutting (.e.g. poplar, birch in lowlands, alder in uplands, ericaceous plants all over).

This process of invasion and capturing of the site by intolerant species is one of the main differences between wildfire and large area clearcutting.

Large areas of second growth balsam fir (frequently now under attack by spruce budworm) is a good example of the unchecked spread of secondary species as a result of harvesting practices. Many sites previously occupied by spruces and jack pine were replaced by second-growth balsam fir. The virgin, fire-originated stands, which dominated large areas and were relatively budworm resistant, were removed and replaced by stands which are budworm susceptible.

It is now generally accepted by foresters throughout the world that, both economically and biologically, a satisfactory system of harvesting such stands is clear cutting. This has become the customary harvesting system in most parts of Canada

Conducted properly, with consideration for the forest environment as a whole, it is a method of logging which frequently produces good natural regeneration.

... When a coniferous forest is clear cut, all the usable trees in a block of forest are felled in a single harvesting operation, and only the seedlings and young trees are left. This avoids losses from windfall, which are very high when a system of partial harvesting is employed in mature stands, especially where there are shallow rooted species like black spruce. It also prepares the way for establishment of a new forest containing, over large areas, a balanced distribution of age classes.
(Canadian Pulp and Paper Association, January 1980)

These generalized statements should not be applied to much of Northern Ontario forest.

4.3 Regeneration of Cutover Lands

4.3.1. Uniqueness of Black Spruce

Black Spruce is a species unique to the boreal regions of Canada. It is sought by industry primarily for its excellent pulp and paper products and represents over 40 per cent of total timber production in Ontario. (Haavisto, Jeglum)

The uniqueness of black spruce as a tree species is based on its role in and adaptability to the northern landscape and climate. It is therefore important that the management strategies of harvesting and renewal should not be guided by strategies which apply to other conifers.

With its unique plate-like shallowness of the root system, black spruce is not a pioneer species like jack pine. Jack pine and black spruce possess different microsite preferences with respect to light intensity, temperature, soil moisture, soil nutrition, and the presence of competing species and vegetation. In their regenerative stage they respond differently to the degree of mineral soil exposure. Both species, however, are frequently seen growing together in fire-originated stands. It is important to be aware of these differences in designing management strategies and prescriptions.

4.3.2. Negative Effects of Current Practices

Management of black spruce should be guided by the natural processes to which the species has adapted. This requires appropriate techniques for harvest and renewal specific to this species, not simply techniques copied from what works with other species such as jack pine. What could be avoided by following these suggestions will be the risks inherent in the pursuit of maximization.

To maintain site productivity and obtain optimum yields of black spruce, the biotic and abiotic factors of the spruce forest must be safeguarded. In ecologically-sound black spruce management in the majority of sites, this task cannot be done by the removal of all trees from the entire landscape. By attempting to maximize harvest volumes without considering the processes of the natural ecosystem, the industry frequently:

- a) removes all spruce trees;
- b) displaces the soil humus, and compacts and disturbs the mineral soil improperly, thus reducing soil productivity and ecosystem stability;

c) destroys most advance growth.

Even with the use of techniques such as CLAG, damage to advance growth occurs on the parts of the site on which the logging equipment operates. Furthermore, subsequent failures to establish vigorous, well-stocked stands lead to further instability and deterioration of the sites' current productivity.

5. BLACK SPRUCE SILVICULTURE

5.1 Reproductive Ability of Black Spruce

The regeneration of black spruce is dependent on moderate rather than extreme conditions of the environment. Wildfire may be cataclysmic at its outset, but moderate conditions are present very shortly after. Establishment and early growth are enhanced by atmospheric inputs of moisture and nutrients. These two factors in turn affect the chemistry of the site and its immediate productivity. While rich, very productive sites with large nutrition pools and soil water holding capacity are less dependent on these atmospheric inputs, to the less productive sites, especially ones called "fragile" and "sensitive," they may be crucial.

5.2 Nitrogen Cycle

Since virtually all nitrogen resides in organic form as opposed to mineral form which is required by the plants, it cycles through the biosphere and the rate of cycling depends heavily on soil micro-organisms. Most micro-organisms which cycle nitrogen prosper best under moderate environmental conditions (i.e. warm, moist, well aerated soils). These processes are largely aerobic.

5.3 Environmental Conditions of Large Cutovers

The removal of trees over a large area creates extreme environmental conditions - high temperature during the day, cold during the night, and increased air movement.

In the cutover forest floor, a rapid and short-term increase in the rate of nitrogen mineralization occurs due to the removal of the trees, increased soil radiation, increased temperature and a decrease in evapo-transpiration which means an increase in moisture. While these processes may have an immediate positive effect on the site, this may be followed by such counter-productive processes as:

- a) excessive leaching of macro and micro nutrients
- b) excessive drying-out of the surface of the humus
- c) saturation of the near-surface soil horizons
- d) mortality of micro-organisms in the feather moss component of humus
- e) excessive capture of sites by certain species of sphagnum and ericaceous plants
- f) possible increase in soil acidity
- g) disappearance of the feather mosses.

As decomposition progresses and the surface organic

horizons dry out or get saturated, the mineralization of nitrogen will decline:

- 1) because of a lack of readily decomposable organic material, and
- 2) because of reduced biological activity resulting from moisture deficiencies, temperature extremes and high carbon-nitrogen ratios in the remaining organic matter.

Competition for mineralized nitrogen by vegetation on the cutover further limits nitrogen availability to the primary species. Competing plants such as Labrador tea and poplar with deeper, more established root systems may be able to compete more effectively for scarce nitrogen resources.

5.4 The Effect of Moisture on Black Spruce Forests and Sites

Wet conditions result when a combination of vegetation and land form conditions do not allow complete removal of precipitation by evapo-transpiration, run-off or drainage. (Gorham, 1957)

After timber harvesting, due to high water table or the blockage of drainage, moisture surpluses are clearly visible on many parts of the boreal forest. This occurs especially on Claybelt sites in Northeastern Ontario, where frequently drainage is already imperfect, resulting

in low productivity of these sites. Similarly, this may occur in the North Central and the Northwestern Regions of Ontario, on the occasional lowlands. In many cases, lowlands suffer serious moisture imbalances after clearcutting. A good example of such moisture imbalances and their impact can be observed on the so-called "pattern sites." These sites are frequently represented in the North Central and Northwestern Regions, and can be described as a combination of shallow till, bedrock ridges, and organic drainageways.

After harvesting the ridges become extremely dry and the low-lying areas extremely wet. On these and other similar sites, the damage occurs not only from extremes in moisture conditions but also as a result of degradation by logging equipment which accentuates the damage through rutting and subsequent ponding and erosion.

5.4.1 The Importance of Atmospheric Moisture

The removal of trees, including their foliage, results in higher moisture inputs to the forest floor. This precipitation is also deprived of nutrient enrichment from contact with the foliage. Coniferous forests can intercept and subsequently evaporate up to 40% of the total annual precipitation.

Interception is important in the water balance of forests because it is capable of "short circuiting" the availability of water to the ecosystem. The direct evaporation of intercepted water (rain, snow, dew or fog) can constitute the major portion of evapotranspiration. This water therefore does not enter the soil moisture store for use by the trees and understorey, nor is it released as run-off to streams. (Oke, 1978)

The interception of precipitation is less after a fire than before it, but still greater than in large cutovers.

5.5 Vegetation Response to Changing Moisture Conditions

The different reactions of the two main moss types of cutover conditions is of interest. The better sites are dominated by feather mosses which desiccate and die off after cutting exposure. The poorer sites are usually the home of the sphagnum mosses and ericaceous shrubs which thrive under wet cutover conditions and may subsequently overgrow feather mosses, debris and even seedlings. The fact that the site is being taken over by sphagnum mosses is a good indication that something detrimental has happened to it because of the changing water table. After wildfire, the role of the pleurozium mosses (feather mosses) which have been burned is taken over by the seedlings, which then create an environment for the pleurozium to return and thus maintain site productivity.

While the water table is high, vegetation which thrives under wet conditions moves in. As the water table stabilizes - and this may take several years - other vegetation moves in, taking advantage of drier conditions near the surface. These combine to form a new and different forest floor. This process is not conducive to spruce growth and frequently hinders the establishment of a new root growth called "feeders".

These processes are also important to the placement of planted trees in such adverse conditions. Black spruce has the ability to produce adventitious roots which can quickly develop on the active humus. The problem is: how fast can black spruce do this, and how fast can the new active humus be developed?

Poor aeration associated with high water levels is detrimental to black spruce growth. Low oxygen levels affect the growth of existing roots and the formation and viability of new roots. Anaerobic soil conditions retard decomposition and nutrient release.

The decrease in root/shoot ratios due to flooding can predispose trees, especially seedlings, to drought injury when the water levels recede. (Zinkan et al., 1974)

High water levels have been discussed and the damage postulated by foresters and researchers for a long time.

This phenomenon could be described as one of the most negative impacts of forest harvesting. A. B. Vincent stated of the areas he studied:

Nowhere has there been a desirable increase in growth rate since cutting.

There is active site deterioration which has been aggravated by the abrupt removal of much of the stand.

The most visible evidence of site deterioration is the presence of a high water table and sphagnum still actively increasing in area and depth to replace the normal feather moss ground cover sphagnum's loose growth habit and holding of nutrients in unavailable form restricts the growth of black spruce reproduction, accenting the results of the shallow root system. (Vincent, 1965)

The "first documented evidence for water level rises in peatland forest types in Ontario following harvesting" appeared in 1989 (Haavisto, Groot, Jeglum, 1989). This was the result of studies initiated in 1963 with the installation of 48 check wells in typical black spruce stands in the Claybelt area.

After the spring 1965 recharge of the system, levels rose an average of 6-7 cm, attaining mean depths of about 32-33 cm. Average water levels remained more or less at this depth during the four year study, suggesting that removal of the stand was the cause.

However, it was not until 1989 that this study was published, providing the first documented evidence for peatlands in Ontario that water levels can rise in some site types following harvesting.

5.5.1 Indicators of Water Problems

In the Claybelt more than 60% of the total productive sites are lowlands with imperfect drainage. It is generally believed that, after harvesting, the water surplus will soon balance itself and the sites return to normal through the presence of new vegetation. Such a belief overlooks the fact that after harvesting, different vegetation often captures the disturbed forest floor. Vincent rightly pointed out that the expansion of sphagnum at the expense of pleurozium mosses is an indicator of a water problem. One can postulate that the removal of pumps, a lack of immediate re-activation of the site surface and the effects of undesired vegetation cause the deterioration of the site. Seedlings established on Sphagnum, as well as the advanced growth, show poor growth in general.

Knowledge of site-specific micro-site conditions which optimize the establishment and early growth of jack pine and black spruce is incomplete due to the lack of formal trials and measurements. Survival and growth of seeded or planted seedlings can be enhanced if field staff involved in the regeneration program rely on their past experience coupled with a solid understanding of the species' ecology and growth habits. Adaptive management will only succeed when the importance of the species' biology is understood and respected. (Corbett, 1989, pp. 97-99)

It is more than obvious that many forest managers neither understand nor respect the biology of black spruce.

5.6 Seedbed - Microsite Considerations for Black Spruce

It has been stated frequently that black spruce seed requires contact with mineral soil and full sunlight to germinate. Closer observations suggest that this is not necessarily so. Quite often, black spruce have been seeded into the sphagnum and feather mosses of the original stand under the slightly opened up canopy. Compacted weather mosses especially can be an excellent medium for seedling establishment. Vidlak, in a series of experiments at the Abitibi Woodlands laboratory in Raith found that the majority of black spruce regeneration occurred on tramped and compacted mosses.

It is evident that under the shade conditions existing on these quadrants, compaction greatly increases the number of germinants. However, even without compaction there is an adequate number of seeds germinated on all these major seedbeds. (Losee, 1966)

These major seedbeds were sphagnum and feather mosses, and litter. In my own experience in modified strip clearcutting, I have found that the shade differences arising from different orientations of narrow strips are not sufficient in this climate to affect black spruce regeneration to a significant degree. This, however, applies only to narrow strips and smaller openings. On drier sites with coarse sandy soils this may not apply.

On these sites seedlings in the open sunlight suffer heavy mortality on the north side of strips laid out in the east-west direction and on the majority of strips in the north-south direction. In these conditions moderate shade is better for establishing black spruce seedlings.

The environmental conditions must not exceed the tolerance range of the young seedlings. (Thomas, Wein, 1984)

Following large area clearcutting the tolerance range of black spruce seedlings may be exceeded by the effects of harvesting activity, exposure, improper site preparation, high water levels and the establishment of undesired vegetation.

Understanding the response of a natural system to disturbance factors is a necessary step towards manipulating, managing or conserving that ecosystem. (MacLean et al., 1983).

For regeneration stock to develop satisfactorily toward stand establishment, ameliorative treatment of a great variety of constraints may need to be considered.

Constraints can be conveniently grouped into three classes: atmospheric, edaphic, and biotic (Table 1). Most of these constraints are complex rather than single factors, and there are many interactions.

Table 1. Factors that commonly constrain tree performance

Atmospheric	Class of constraint	
	Edaphic	Biotic
Wind	soil depth	harvesting residue
Air temperature	soil temperature	competition
Radiation	soil moisture	pest fauna
Humidity	soil texture	harvesting ^a
	soil structure	site preparation ^a
	soil bulk density	regeneration stock ^a
	soil fertility	tending ^a

^a inappropriate method or execution

Source: R.F. Sutton, 1990

5.7 Forest Ecosystem Classification

Recently, field guides for forest ecosystem classification in northern Ontario have been published. It is mentioned frequently by the MNR and industry that these guides will help forest managers to recognize vegetation and soil features in forest stands and to allocate a stand to an operational group within the classification. The intent of these guides is to help forest practitioners in better decision-making and both harvesting and silvicultural prescriptions. These worthwhile documents have one important drawback. All sampling was done in virgin, natural forest and results apply to the natural, mainly fire-originated conditions of the ecosystem. The successional trends after harvesting and their impact on the ecosystem are not considered in the FECs.

I have tried to indicate that many processes following harvesting may impact sites detrimentally. In some cases, it is the forest flora which may serve as an indication of such negative effects. This is not mentioned in the guides. There seem to be two reasons for the inadequacy. Firstly, the scientists responsible for these guides may not recognize that successional changes after cutting exist. Secondly, if they do recognize them, they consider them of minor consequence to site productivity and not worthy of mention. It is important that the forest manager uses silvicultural prescriptions that take into account the changes in the forest floor caused by harvesting perturbations. The water table in the logged area has a profound effect on many boreal forest sites including the floristic components of the new forest floor. The ecologically based site classification, which does not recognize such changes and does not incorporate soil moisture dynamics, is only partially useful for black spruce management.

6. BLACK SPRUCE FOREST RENEWAL

6.1 Results of Cutover Studies in the Lake Nipigon Area

In the 1970s, an effort was made in the OMNR Nipigon District to document the dynamics of growth on cutovers currently under the Lake Nipigon Forest FMA. This resulted in a two-year study into the conditions of older regenerating stands and an assessment of their regeneration (Clemmer, 1973). In a separate study, the St. Lawrence License cutovers were assessed by Clemmer and Atkins in 1979. These reports provided the OMNR with details of black spruce dynamics as well as patterns of regeneration growth and yield on different cutover sites within the various working groups. In this research over 98,000 acres were surveyed. Results suggested that nutrient imbalances would lead to reduced productivity:

... a lack of sustained cutover yield development beyond 20-30 years on the poorer quality spruce, hardwood and particularly the jack pine sites is also suggestive of a serious nutrient imbalance. Such a nutrient imbalance could logically develop due to excessive nutrient loss following logging. (Clemmer and Atkins, 1979)

It is generally recognized that harvesting results in some removal and depletion of the site nutrient capital, regardless of the logging system used, because it removes

some nutrients and disrupts nutrient retention mechanisms. (Rennie, 1957; Weetman and Webber, 1972). In mature and over-mature forests the cycling of nutrients becomes more tightly controlled and a greater proportion of the nutrient capital becomes locked up in unavailable forms. Wildfire releases these nutrients, thus recharging or rejuvenating the system.

Harvesting disrupts this system before natural disturbance can take place. What follows is that the available nitrogen pool is increased on the site due to decreased plant uptake. Available nitrogen is a function of the net result of mineralization and immobilization of nitrogen.

The potential of the litter substrata for decomposition is largely dependent on the quality of readily energizable Carbon and Nitrogen present which functions as an energy source to boost the decomposition rate. Facts that could affect quality of readily energizable carbon and Nitrogen at a site include the nutrient status of the site and pH. The relationships between temperature and Nitrogen mineralization is attenuated at either excessively high or excessively low moisture content. It is important to realize that with saturation of a decomposing forest floor, a decreased rate of Nitrogen turnover was observed and that the mineralization of Nitrogen will be maximized not only by increasing temperature on the forest floor, but also by maintaining moisture conditions around field capacity. (Clemmer, 1975)

Because micro-nutrients such as boron are sensitive to the above relationships, its presence or absence is closely related to the carbohydrate carbon.

The reduced availability of carbohydrate carbon in the age period of 20-50 years restricts both ammonia-nitrogen release in the forest floor and volume growth. (Clemmer, 1973)

On a site with very slow replacement and/or poorly developed nutrient accumulation mechanisms, even a small loss may take a substantial period for replacement. (Kimmins, 1974)

On nutritionally poor sites (where the initial site capital is only marginally above the critical level) loss of growth may occur in the second or third rotation while on the richer sites there may be no obvious effect for 4 or 5 rotations. (Kimmins, 1974)

In Alaskan spruce forests:

Whole-tree harvesting or harvesting that removes any biomass other than boles to the harvestable top diameter should be avoided at all costs. (Gordon, 1986)

Practices such as clearcutting and broadcast slash burning, which are ecologically sound management tools on some sites, have been applied ubiquitously and uncritically, often with highly undesirable results. (Kimmins, 1974)

It is my impression that full-tree harvesting has indeed been applied in Ontario "ubiquitously and uncritically, often with highly undesirable results," as Kimmins found in British Columbia. Of course, full-tree harvesting is one of the most economical methods of timber harvesting. Industry also emphasizes the benefits of higher yields from cutovers. This can be disputed when one sees the large piles of tops and debris accumulated along the road-

side instead of being left all over the production area in reasonable quantities. However, on lowland sites on the Claybelt, debris left on cutovers is often quickly overgrown and removed from the active nutrient pool by certain Sphagnum moss species.

The removal of the slash from the planting area may make it easier to plant, but on many sites it may be very difficult for the seedlings to grow and prosper. When one includes the additional negative effects of site preparation, frequently done on marginal sites, one may question the regeneration attempts and longest-term tree production capabilities. The benefits of tree-length logging, in terms of site nutrition, were indeed recognized by the industry.

The tops and branches, known as slash remain in the forest and return their nutrients to the soil. If the site is such that nature will provide for fast and adequate regeneration, then slash is left to decompose, and generally, provided rainfall is adequate, this process will be completed within 5 to 10 years. (Canadian Pulp and Paper Association, 1980)

In the '60s and '70s large areas of homogeneous black spruce plantations were established in the Lake Nipigon Region under my planning and supervision. Where mixedwood cutovers were converted to spruce monocultures, past experience indicated that in order to grow artificial,

even-aged pure spruce stands, one must have:

- a) justifiable expectations of considerably higher yields. This was done by examining the site history, the yield of previously cut timber and the productivity of the sites themselves.
- b) some idea of the stability of such forests and the means to maintain it.
- c) proper spacing of planted trees to achieve early crown closure in order to safeguard the internal stability of the new stands.
- d) the means and financial back-up for continuous tending the ability to monitor growth performance
- e) knowledge concerning, and strategies for dealing with possible risks

Because the area considered was large, different geologic and site productivity conditions were found. At that time, the full tree harvesting system was just developing and concern about the effects of this method on different sites in the Northern regions of the boreal forest had been expressed.

As a result, a study of nutritional aspects of full-tree logging in the Nipigon area was published by Timmer, Savinsky and Marek (1979). Four sites of different

productivity based on soil analysis and the status of the original stands were selected for the research. After the sites were harvested by full-tree logging, two of the areas were site-prepared and planted. On three sites monitored by me, the results were as follows:

- a) the most productive site, which previously supported a deciduous stand, was not planted or treated after cutting. It regenerated to poplar and birch. Where large amounts of slash and debris were left, no regeneration occurred. This indicates that a large amount of harvest debris can act as a deterrent to regeneration.
- b) the site of intermediate productivity, which previously supported a young second growth stand of mixed balsam fir, poplar and birch and was logged by the full tree system was planted to black spruce, white spruce and jack pine in alternate rows. The trees are growing well, especially the jack pine which had formed the original stand harvested in 1930. However, two chemical tendings were done in order to release the plantation from aspen competition. More tending will be required.
- c) The least productive site, a shallow, mineral soil over bedrock site which previously supported a black spruce forest, was site-prepared and planted to black

spruce after full tree logging. Presently, the plantation is doing very poorly and has 30-40% mortality. The lower lying areas have completely failed, due to water saturated conditions. Some advanced growth which survived logging and site preparation is showing fair growth and does not have the chlorotic appearance of the planting stock. On the edges of the cutovers, where some black space was left standing, natural regeneration is plentiful on microsites prepared by scarification, no chlorotic appearance is evident and fair growth of the regeneration is visible.

There are substantial areas of forest in the world in which the application of current technology of the region result in either excessive successional retrogression, excessive depletion of the site nutrient capital or some other ecological change which will seriously impair the ability of the site to grow trees." (Kimmins, 1974)

6.2 Tree Planting in the Boreal Forest

... the target may be to plant 200,000 seedlings, and the progress or result that is reported, and used to evaluate performance, is the number of seedlings planted. There is no visible reference back as to why the seedlings were being planted in the first place, and no assessment as to how well the number planted were able to grow and thereby contribute to solving a specified resource management problem. (Baskerville, 1986)

There exist significant differences in the resistance of spruce stands in commercial and natural forests. The artificial spruce ecosystems are more endangered by abiotic and biotic harmful factors. They require a continuous phytotechnic and protective

intervention. (Stolina, 1979)

Implications are more serious to plantations on regenerated stands stocked only to mandatory provincial standards, and to precommercial thinnings regimes. Most stocking standards including legislated minimum standards applied in Alberta, assume little or no mortality between crop establishment and semi-maturity. (Bella, 1978)

One of the dangers to the newly established spruce plantations in the northern forest is spruce budworm infestation. The new artificially established stands are surrounded by second growth balsam fir or the old low value mixed wood forest. Both are host to this pest. As long as these stands will be able to survive and maintain new generations of budworm the plantations will carry a high degree of risk. Considering that millions of hectares of growing stock close to the mills are involved, the consequences could be disastrous. (Marek, 1989)

The above lines illustrate the problems I have found in planted cutovers. Since the beginning of FMAs, tree planting has become a silvicultural priority. This kind of "intensified silviculture" hopes to provide new and better, fast growing black spruce and jack pine stands ready for harvest by the year 2020. It also hoped to counter-balance the poor conditions and volume deficits in the second growth on past cutovers. It naively assumes that the yield from these stands will be much higher and on a shorter rotation. At present, jack pine and black spruce seedlings are being planted on sites that range from water-saturated lowlands to dry, bedrock uplands and Protection Forest Reserves.

A typical problem for the forest manager nowadays is the dilemma of where to put all the trees. Seedlings are being "shoved" into places where the same coniferous species has already established itself naturally and is growing well. One finds planted trees on desiccated, sterile feather mosses, among bullrushes, little pockets of soil between bedrock, on skidways, anywhere. Some of the areas planted are only a few miles from the mill while others are 150 miles or more away from the mills.

Planting is often put forth as the universal cure-all but planting all cutovers in a forest where there is ample natural regeneration is a waste of money and that is not good management by any definition. Planting by itself is a useless measure of management quality. (Baskerville, 1986)

6.2.1 How Does Tree Planting Fit Into the Condition of Cutovers?

Broadly speaking, in the Claybelt approximately 20 per cent of the annual cutovers are in productive uplands on deeper mineral soils. In the North Central Region the percentage is probably double that. Prior to cutting, these sites are usually occupied by mixedwood stands. The species association differs, but white spruce, black spruce, jack pine, and balsam fir are the most important softwood components. After the softwoods are harvested, the residual deciduous trees, if not

utilized, are killed by chemicals. This is followed by mechanical site preparation (corridoring or bräckeing) to accommodate the planting of black spruce. The resulting coppicing and suckering of deciduous species require further chemical tending. This often results in the proliferation of grasses and low shrubs. While the coniferous stock, mainly black spruce, is doing fairly well, though not showing exceptional growth, it is to be expected that a heavy influx of trembling aspen, originated from seed, will again cause a problem. Further repeated chemical tendings will be required even beyond the age of 20 years after planting. It is and will continue to be a vicious circle.

The survival of spruce is generally satisfactory in upland plantations. Some failures were noticed in low-lying areas and drainages. This is caused mainly by saturated conditions, heavy competition from sedges and grasses and the effect of frost. Failures in Claybelt uplands may occur where site preparation does not remove the desiccated feather moss duff, and seedlings are then planted into this dry duff.

On sites with plentiful advanced black spruce regeneration, seedlings were planted right beside

those occurring naturally. In some cases, the naturally seeded trees of layer origin were growing much better than the planted ones.

The impact of harvesting machinery is still clearly visible and adversely affects the efficiency of planting. On organic sites forwarders and skidders still rut the surface in their travels toward the road, thus exposing the organic substrata. In shallow sites, the machines break up their surface layer of mosses, exposing the bedrock and predisposing the site to erosion. The percentage (between 20 and 50 per cent) of areas damaged this way may vary depending on topography, layout and site conditions. This includes the areas where delimbing and slashing took place and large piles of debris are accumulated.

The problem of logging debris and its interference with planting shows clearly on sites harvested by forwarders which leave corridors of this material. These "corridors" are almost impossible to plant properly and reasonable growth should not be expected.

The outcome of planting is heavily dependent on the

quality of planting stock as well as site preparation. Container stock quality is still below my personal standards. Spruce bare root stock is usually satisfactory. On some planting projects the container stock has already flushed out, jeopardizing planting success.

The quality of scarification depends on the equipment used and the skill of the operator. In recent years, new machines have been used, but uniform site preparation prescriptions are used over the entire landscape. For instance, heavy barrels or bräcques may be used on uplands and lowlands under all site conditions. Recognizing that the damage is done mainly by the prime mover, the indiscriminate use of a single type of equipment over the variety of site conditions contributes to the problem. This is perhaps more important on black spruce sites than on jack pine sand flats.

The timing of harvesting and silvicultural treatments is a very important in regeneration success.

Receptivity of microsites for successful regeneration is at its peak right after harvesting:

Intensive post cut ground surveys conducted in recent cutover on Abitibi-Price Inc. Smooth Rock Falls licence revealed that over 40% of the surveyed

cutover has been rendered untreatable and unregenerated because of lowland site damage. Site damage is attributed to the use of inappropriate logging equipment during the frost-free season. An additional 16% of the cut is judged to be too remote to treat economically. Only 34% of the total cut may be planted. Surveyed areas were within 6-40 km from the mill. (McColm, 1983)

The liquidation of high volume black spruce stands has been in progress for over 50 years. Large area clearcuts followed by planting can be seen on sandflats and "rock piles", as well as everything in between, including Protection Forest Reserves. In many areas, the stands harvested were black spruce but they are being regenerated into jackpine. We are therefore witnessing stand conversion, from black spruce to jack pine, and replacing the highest quality fibre with lower quality fibre.

We are also witnessing the encroachment of logging on marginal sites, identified on the FRI as "PFR", Protection Forest Reserves. These areas were designated as PFR due to the exposed bedrock and shallowness of soils over bedrock sites of marginal productivity in the original FRI. To include them in the designation of productive, harvestable forest with resultant timber removal will lead to reduced productivity on these sites. These sites are

frequently left untreated after harvest, and abandoned to "natural regeneration" leading to the disappearance of primary species which originally occupied the sites and the appearance of volunteer species. These actions do not result in management which upgrades the quality of the forest. The fact that the productivity of the forest may have been lowered by these and similar decisions may puzzle some of us. This approach, however, does fit in well with the utilitarian philosophy of the logging industry.

There are also many problems with jack pine plantations. Some of them are already visible, and others can be anticipated in the future. They are:

- a) improper out-planting of jack pine bare root stock causing improper root development and deformation. Such root systems provide poorer mechanical support, particularly on shallow mineral soil over bedrock sites.
- b) the problem of insects and diseases which may wipe out many trees in the plantations - especially if they are already weakened by poor root development or poor nutrition.
- c) multiple leader growth and deformed stems in some plantations.

During my recent field trips, I have examined many plantations and have observed all the above and substantiated my previous findings and observations. The

conversion of black spruce to jack pine stands is more evident on richer sites than on less productive ones. Large area continuous clearcuts accentuate problems with the mechanical stability of planted jack pine because of increased exposure to wind, insects, and diseases.

6.3 Problems of Seedling Quality

In the effort to mechanize silviculture, the difficulties experienced in stand development may be forgotten. In the context of this report, I should like to quote from Walters:

The long-term nature of forest growth should make the mere risk of plantation instability and debilitation as a consequence of root disturbance during planting, unacceptable.

Certainly little is done in reforestation to suggest that foresters are concerned about the roots of planted seedlings. 'Out of sight, out of mind' is perhaps an inappropriate maxim to describe the present attitude towards the root system. (Walters, 1978)

Forest managers know that planted seedlings may develop deformed root systems which, in turn, may affect the growth and forest yields.

It was obvious right from the beginning of the FMAs that an increase in seedling production was essential and even of primary importance. Privatization of seedling production was undertaken on a large scale. The question

of standards inherited from the OMNR nursery experience plagued these private nurseries from the beginning. This was not only a technical problem of available knowledge, but also a question of quality vs. quantity. The OMNR has often failed to produce good quality planting stock in the past. For example, for seedling production expediency, the "Ontario tube", 3-0 seedling stock was developed (seedlings raised in plastic containers for 3 years in a seed bed, not transplanted before planting) and even poor quality transplant stock, often against the desire of foresters who wanted large transplant stock to help combat competing vegetation. Nevertheless, the "customers" (field foresters) were forced to take what was made available to them or be reprimanded for not attaining their output targets.

There was little, if any, improvement when the mass production of coniferous stock was placed in the hands of many inexperienced private entrepreneurs. Instead, the situation got worse. Standards of seedling quality were compromised and private growers were pushed by the MNR into higher production. Even the logging industry has started to refuse the stock offered for planting. Only jack pine and black spruce planting stock is now grown. No white spruce planting stock is produced. At present, due to targets and commitments of the program, which is

financed entirely by the OMNR, the greenhouses are being forced into maximum production, with insufficient expertise.

The recent announcement that the Northern Region will be producing 82 million trees for planting by 1990, coupled with the announcement that a scientific group will be simultaneously established to set "standards" for tree quality and growth is a typical example of working backwards.

Individuals involved in tree planting have frequently complained to me regarding problems in the field, and as a forestry consultant, I have observed the difficulties occurring in the field.

All too frequently, the contractors for the OMNR and the forest industry are pointing out difficulties with the quality of planting stock. "You plant what you get," is the usual answer to any complaint. This is in complete contradiction to the basic rules of sound forest renewal. It inevitably leads to cynicism in the planters and contractors. The OMNR has recently imposed stricter rules and supervision on the contractors but the quality of the planting stock has deteriorated to such a degree that in many cases, the planters have been refusing to plan "dead"

or "half dead" trees. They have dared to question the contractor who was their employer, and the OMNR supervisor on their project. The answer from both sides was - "You plant them." Occasionally the planters refused to comply and went home. In several cases the contractor defaulted on his contract and left the trees in the bush. The OMNR eventually disposed of these seedlings by burning them after trees were left in storage along the road for weeks.

I have discussed this and other problems with several planting contractors. They usually admitted that this was just one business venture in which they got involved, although some did express some concern.

6.4 Neglect of White Spruce Seedling Production

The neglect of white spruce seedling production and white spruce regeneration in general is to be regretted. It is frustrating that so little is known about a species which easily produces trees of saw-log size and good fibre in a relatively short time. The volumes harvested annually from natural stands in the boreal forest are considerable and it is of prime importance to the lumber industry of Northern Ontario. These areas, also occupied by other species such as aspen and birch, are being converted after cutting to black spruce and jack pine plantations instead

of being reforested to white spruce. One stated reason for the conversion of white spruce mixed woods to black spruce plantations is to avoid possible damage by spruce budworm. However, the black spruce plantations may also fall victim to this pest. It seems that the regeneration of white spruce by the "seed tree system" has been completely forgotten. This is a method which can produce excellent results. All that is required is that some trees be left during cutting, and proper site preparation of the forest floor be done. Because white spruce produce cones only once in four years, some planning by the forest manager is also essential

7. OTHER REGENERATION TECHNIQUES AVAILABLE

7.1 Direct Seeding as a Regeneration Technique

The direct seeding of jack pine may be described as one of the successful techniques for the management of jack pine sites in the boreal forest. Failures which have occurred can largely be ascribed to excessive logging debris, inadequate site preparation, improper site selection and lack of tending. Results have improved because of better utilization which makes site preparation more effective and consequently allows for the production of better seed beds. Site preparation technology for jack pine seeding has also improved. However, in other areas, poor timber utilization continues to make site preparation extremely difficult.

Seeding of cutovers by the direct application of black spruce seed has been considered by some to be an ideal answer to regeneration problems. Many trials have been conducted, most of which are stressing the difficulties to be encountered with this activity. The results depend on many factors among which the microclimate of the site and the quality of site preparation are major considerations.

It could be said that the results from black spruce direct seeding trials in the North Central Region could be improved to some degree by better site preparation. Such careful treatment will be very

site specific and will depend on the ground cover, the moisture regime and the parent material of the site. This delicate site preparation may consist of the partial removal of humus by means of scalp and narrow furrows. Under no condition should organic peat or muck be disturbed or spilt over. It is doubtful that only one application of seed on such microsites will produce satisfactory stocking. (Marek, 1983)

The condition of seedbeds and their stability after large area clearcutting plays a major role in the establishment of germination and the survival of seedlings. A lot of energy and money have been spent on trying to force the issue - to "force" black spruce seed to grow without taking this into consideration. While black spruce regeneration from seed is nearly always successful after natural disturbance, the artificial application of seed on large area clearcuts has usually been a failure.

The "tolerance range" of black spruce is much narrower than that of jack pine. On a number of site types large area clearcuts do not provide seedbeds within this "tolerance range". When seeds do germinate and start to grow in cutovers, they may encounter continuing difficulties as site conditions change adversely. One example is the prolific growth of sphagnum moss which smothers germinants and small seedlings.

Species diversity and specialization reach a maximum level during the regeneration period and during the early stages of young stand development when the

dynamics of change is also maximal. (Symposium on Stability of Spruce Forest Ecosystems, 1980, Czechoslovakia)

7.2 Site Preparation in the Boreal Forest

Site Preparation is an important aspect of forest renewal. The purpose of site preparation is to create microsites for seeds or planting stock, and to renew the site productivity. It may be beneficial, favourable or detrimental if improperly applied. It is possible to damage severely the physical and biological make-up of the forest floor and destabilize the processes therein. As an example, site preparation may improve the soil's nutritional status or damage it. It may lower the pH level or raise it. It may improve water movement or hinder it.

The technologies of site preparation are still primitive and should become more innovative. Problems include equipment, the use of equipment, and the proper understanding of microsite optimization. This applies especially for large area treatments where optimum results are seldom achieved. If this optimum is ever to be achieved, changes in the site, triggered by the removal of the trees, must be considered. In this way, harvesting can be seen as the first element in site preparation.

The use of chemicals as a site preparation tool may be gaining acceptance in industry. However, it is frequently questioned by the public and the assumption of damage to the environment is highlighted. Knowledge of the effects of chemicals in the boreal forest is incomplete. We are still in the infancy of biologically sound management and what the most appropriate use of chemicals should be.

In the boreal forest there are many examples of the misuse of site preparation e.g., the use of heavy scarifying equipment on inappropriate sites. In the Claybelt, "shear-blading" is a good example of this. Developed specifically to stimulate the activity of the forest floor in the establishment of natural black spruce regeneration on sphagnum-rich sites, it has deteriorated in some cases to nothing more than snow ploughing to align the logging debris in order to accommodate tree planters in the spring. The silvicultural effectiveness of this activity is questionable. This is extremely expensive snow ploughing!

7.3 Natural Regeneration of Black Spruce on Large Area Clearcuts.

In the OMNR Timber Management Planning Manual, renewal options are divided into two main groups; natural regeneration and artificial regeneration. "Artificial

regeneration" is an easily understood term and concept. However, "regeneration by natural means" often provokes confusion. After clear-cutting and doing NOTHING, the forest will still recreate itself. The problem is - to what?

Since logging started in the boreal forest, the idea has been perpetuated that the quality of regeneration need not be questioned. The quality of natural regeneration which constitutes many second growth forests is, in many cases, poor. It did not cost any money, it grew on its own, but it has not become what industry expected and hoped for. This is the forest that industry was depending on and has been described by some as "junk forest" and "silvicultural slums". This is the forest to be harvested by the year 2000. This "second growth" forest is the result of man-made disturbance under the guise of management.

Man has the tools to guide the forest in the right direction without jeopardizing its future and productivity. However, this process must begin at the time of harvest.

In the concentration on the business of logging the fact is overlooked that in order to establish an enterprise in forestry definite, intentional measures to provide for reproduction of the desirable species must be taken at the time of logging, (emphasis added) else it may not take place. (Chapman, 1950)

Black spruce stands established by applying "intentional measures" during harvesting, such as modified cutting, or small area clearcuts and site preparation, produce higher quality regeneration from seed. In many cases such regeneration competes favourably with trees planted and has lower mortality. This regeneration is also called "natural" and is frequently established on microsites created by careful site preparation where trees could not be planted, e.g. shallow soils, rock niches. (Marek, Fry 1964)

Some natural regeneration of black spruce develops from "vegetative reproduction", a process similar to suckering, instead of from seed. Studies are pointing clearly in the direction of higher defects and poorer quality wood there. (Lynn, 1962). On the upland sites, balsam fir replaces the spruces.

8. ISSUES IN THE USE OF MODIFIED HARVEST, FIRE, AND STAND TENDING

8.1 Modified Harvesting of Stands

In the past and even now, normal operations have been and are conducted with minimal consideration of site protection and forest renewal. Current logging strategy, including road location, equipment selection and season of harvest, must be changed if significant improvements are to be obtained.

Modified harvesting or cutting can be described as a harvesting method where the trees are cut from a strip or block limited in width and length by a previously determined pattern, but where no rigid pattern is necessary. Between each cut block a similar sized block or strip is left standing which provides shelter and seed and limits possible drastic changes in the moisture status of the cut site. Forest managers often fail to recognize the benefits of modified cutting with its plentiful seed supply and the subsequent establishment of fully stocked black spruce natural regeneration.

Modified harvesting is a necessary requisite for several silvicultural systems which fall within the general category of small area clear cut management, e.g. strip cutting, shelterwood and group seed trees. The main

benefits of small area clear cut management lie in the effects of the standing timber on the micro-environment. Following clear cutting, water fluctuations cause detrimental changes to the forest floor, i.e. moisture surpluses to start with and deficits later on. This prevents the normal decomposition of humus, increases the acidity and limits microbial activity. It therefore provides a poor environment for "advanced growth" (layering) and seedlings established prior to or during harvesting. The forest floor provides the basic nutrient capital for the trees by the mineralization of nitrogen. The moderating effects on wind, air temperature, radiation, humidity, and precipitation of the surrounding standing timber on the micro-environment are, therefore, of vital importance.

On thin soiled rocky sites the exposure to direct sunlight causes excessive drying. In the lower lying areas clearcutting results in an accumulation of water and the establishment of sedges and grasses.

The field forest managers are usually aware of these problems and are in favour of modified cutting as a biologically sound practice. However, at the corporate level, government and industry do not recognize the benefits of small area clearcut management and wish to

maintain the status quo. Recognition of the need for change is present at the field level. I hear comments to the effect of:

We clearcut large areas of black spruce lowlands, turning them into rice paddies and hope that black spruce will rise again to its previous glory.

We clearcut black spruce Protection Forest Reserves on rocky hill sides and then spread thousands of jack pine seeds all over them in the hope that we will get a valuable crop in 50 years.

Ten years ago the ground rules for FMA's were discussed and silvicultural prescriptions entrenched. It was obvious at that time that both the OMNR and industry were favouring tree planting as THE major regeneration technique, regardless of site conditions and costs incurred. I suggested at that time that considering the makeup of the boreal forest in northwestern Ontario, which is composed mainly of a mixture of large areas of shallow, rocky sites and deep organic sites, small area clearcut management should be a major technique. Regeneration would then occur naturally with the help of appropriate site preparation. This would also save money by reducing stock production and planting requirements and the use of herbicides. These arguments were dismissed with the remark that the areas suitable for such management techniques were of "postage stamp" size. Industry applauded this decision because it gave them a free hand

to continue large area clearcutting, while at the same time postponing any genuine integration of logging with silviculture.

8.1.1 Road Building

Road building is an important element of the planning of modified harvesting. Generally, all weather roads are not located with regard to specific sites but are positioned to provide cutting opportunities within a certain distance on each side of the road.

It is estimated that approximately 16 per cent of the cut is regenerating naturally to acceptable conifer species. The potential of increasing this contribution appears particularly good on specific sites if the sites are protected and if modified cutting is considered.

Planting can presently be considered on only one third of the cut. Frequently the areas closest to all weather roads and potentially the most attractive to plant, suffer the greatest amount of site damage from logging equipment and wood landings. Consequently, available planting areas are often small, scattered, difficult to access and will be

difficult to tend. In turn, treatment costs are higher.

Prior to FMAs, industry financed all road building and as modified cutting increased road building requirements and maintenance, it also increased the companies' costs. It was understandable, then, that industry objected to small area clearcut management. One of the main planks in the FMAs is that government now finances much of the road building, thus removing this extra cost as a valid argument against the use of modified cutting. (Ketcheson, 1982)

8.1.2. Blow-down

By its partial removal of trees, modified cutting has often been blamed for large amounts of blow-down.

This was dispelled by another CFS study:

It appears that the problem of wind-throw caused by partial removal of timber in strips is not as serious as stated by the industry. (Fleming and Crossfield, 1983)

This report also suggest that the blow-down could be reduced by better site selection and strip layout.

Historically, the logging companies have been reluctant to salvage any blow down even if and when created by their own activities. The reasons

frequently given were decreased productivity in such an undertaking, higher costs involved, and safety. It has been shown on many occasions that if proper cut layout and site specific site preparation was done and protection of modified areas maintained, new natural stands from seed could be achieved in two to five years.

One of the main problems in silviculture today in the Boreal forest, aside from ecological misunderstanding, is the need for an effective and efficient method of sound economical renewal. (Marek, 1983)

8.1.3. Modified harvesting in contrast to silvicultural intensification

The reliance or dependence on expensive artificial reforestation techniques is no assurance of success on many fragile sites and may lead to waste of public funds. In highly intensified timber management programs fertilization and forest drainage may be applied. Here the forest manager assumes the responsibility for "forest production". We seem to ignore the fact that this is one responsibility that could be left quite safely to the forest itself. There are specific areas in the world (eg. Scandinavia) where fertilization and site amelioration are indeed cost effective programs. In the Boreal forest such areas are few and far between.

The application of these techniques in the management of spruces is questionable.

8.1.4 Benefits of modified harvesting for other users

One additional benefit which deserves serious consideration is the fact that by small area clearcut management one can adjust timber production to facilitate other forest land uses. In this way a variety of user groups could be accommodated. At present we are witnessing conflicts between different groups of users leading to polarization and fragmentation, e.g., timber production vs recreation. True "multiple use" will not materialize until a more holistic approach is adopted by all users of our forest lands. Small area clearcut management would be a good start in this direction.

8.1.5 Summary comments on modified harvest

There is nothing wrong with clearcutting. There is plenty wrong with the way we do it and where we do it.

Fragile upland black spruce sites pose an all too familiar dilemma to the silvicultural forester. After clear cutting, regeneration can be hampered by shallow, easily eroded soils, exposed rock, high winds and hot, dry seedling micro-climates. (Smith, 1989)

The Canadian silviculturist must understand the natural ecology of the species he works with and, where necessary, either use nature as a guide or

improve on it. (Brand, 1989)

I am informed that at a recent conference in Fredericton on "Natural Regeneration Management", (September 1989) Gordon Baskerville, in his concluding remarks indicated that it is time for the true believers in natural regeneration to come out of the closet and for some serious work to be done to exploit the natural regenerative powers of the forest. "This time, let's get it right. Let's technically inform the driving forces and public opinion". One can conclude that one must address each type of forest as a natural biological unit and manage it on that basis.

8.2 Tending of Regeneration

Tending of young regeneration, natural or artificial, is an important task in forest management activities. If it is neglected or done improperly, the trees will not reach maturity and the investment in the forest could be jeopardized. Past practices are littered with examples of neglect of protection of the investment. Now that the FMAs provide money for this task there is no excuse for further neglect in protecting this public investment. However, problems exist with the habitual use of chemical herbicides. These herbicides are often applied improperly and in anticipation of problems which may or may not develop. While the directions for use are precise and

clear, the reaction of the plants is often unpredictable.

My examination of areas following the application of chemical tending throughout the boreal forest showed differences in results even when and where identical chemicals and prescriptions were used. In some cases, damage was done to the very trees which should have been protected from competition. Just as manual release (cutting out the competition by hand) will never be a "one shot" treatment, with chemical tending repeated treatments will also be required. This is most visible where the competition is trembling aspen.

Trembling aspen is becoming the major competitor on large area clearcuts on more productive sites after site preparation. It appears that we are at just the beginning of a complex problem that did not occur in the past.

The problem with aspen competition and its seeding-in is directly connected to the large areas of clearcuts where trembling aspen has the opportunity to disperse its seed widely - and makes the most of this opportunity.

Trembling aspen ingress is especially prevalent when the sites have been site prepared. The temperature and moisture of the scarified surfaces are ideal for the germination of aspen seeds. While present in fire-

originated stands of jack pine and spruce, trembling aspen has only sporadic representation. On clearcuts aspen can originate from individual trees or stands by-passed during harvesting. Some of these could be a great distance from the seedbed area. The seeding of aspen is not a well-documented phenomenon. While suckering occurs immediately after disturbance and usually persists for several years, seeding-in will occur as long as the seed source is present and the seedbed remains receptive. It is my observation that most forest managers are poorly equipped to deal with this long-term problem. Lack of knowledge and blind faith in chemical tending seem to be the main factors.

It is obvious that the timing of the initial chemical spray is of great importance and requires an intimate knowledge on the part of the manager of the dynamics of the vegetation on each site.

The spraying of public roads and rights-of-way is unacceptable. The sides and banks are excellent habitat for berries, fruit-bearing shrubs, etc. What is being done all too often is "blanket spraying" of a total area, including places where it is not necessary, or is even detrimental. Some of these chemicals are very expensive and when areas are sprayed without needing it, causing

damage to beneficial vegetation and trees, it shows that spraying must be conducted with more care.

In some cases, the use of manual tending to release patches here and there would be cheaper and more effective than the aerial application of chemicals. Ground application of chemicals, using spray guns and applying chemicals to the base of trees would also be more efficient in specific instances.

8.3 The Use of Fire as a Silvicultural Tool

In the 1950's and 60's we used fire extensively in Geraldton District on fresh cutovers to determine its usefulness in silviculture, and to document the difference between natural wild fires in standing timber and on cutovers. The burned over areas were immediately planted or seeded and results are still being followed. In the past few years the OMNR has been using "prescribed burning" (essentially the same thing) for similar purposes. I have visited several of these as well as other areas proposed for this treatment.

Some results are encouraging but it is obvious that the use of fire should be limited to certain sites. For instance, nutritionally poor and shallow till over bed-rock sites should never be burned. The ensuing

plantations will often suffer from nitrogen deficiencies for a long time. Some plantations are chlorotic and show poor height growth after 20 years. On mesic, more resilient sites with sufficient nutrient capital, the use of fire shows its true potential.

There is one aspect of fire as a silvicultural tool which should be stressed. It has been well described by Hesselman as it applies to the spruce forest in Northern Sweden. He states:

A good regeneration of spruces cannot be expected unless the humus of the forest floor is changed to a new, active condition. In order to do this, one must learn from nature. The past young, vigorous spruce stands were of wildfire origin. These processes can be established on the harvested areas. The forest floor, however, must be rejuvenated and become productive. The impact of climate, soils and moisture are important factors. However, only the active humus conditions will give the site the opportunity for full production." (Hesselman, 1937)

It is my observation that many prescribed burns do not fulfil the criteria outlined above. This is mainly due to the lack of deeper burning into the humus.

8.4 Multiple Use of Forest Lands

Separation of Timber-Producing Activities from Other Forest Uses

The boreal forest has been a timber producer from its beginning. The last 30 years have shown an unprecedented mechanization of logging, using large and expensive

machines. There are signs that the logging industry may not be able to maintain its current production. There are also problems with regeneration where manual labour is involved, e.g. tree planting.

On the other hand, recreational use and tourism are slowly but surely expanding and asserting their rights to the boreal forest. This is already having an impact on forest management in Northwestern Ontario. The targets of forestry for timber production are being set in isolation, oblivious to the demands and needs of these other expanding industries. There are bound to be conflicts. Some OMNR solutions (e.g. management guidelines for other users) are little more than "band-aids". The problems that the OMNR is now experiencing are largely of their own making, at more senior levels, following as they do the policy decisions of previous decades. The "multiple use" concept introduced in the 1970's with public participation is not satisfying the majority of forest users. OMNR bureaucracy, guided by a strategy of reconciliation, has not been able to provide useful documentary information to resolve complex problems. The lack of pertinent data in the hands of management staff and a lack of experience and understanding, relegate OMNR personnel to the role of observers rather than managers.

Government guidelines and plans are cancelled or modified frequently, creating an atmosphere of public mistrust. This also demonstrates the weakness of our present forest "laws". Frequent changes by industry in their operational planning only compound the problems.

It has been commonly accepted by OMNR that the logging industries' needs are of primary importance. It is no wonder then, that the interpretation of "multiple use" by the logging industry has evolved into "sequential use". After timber has been harvested and sites regenerated or abandoned, other users can indulge in all the "multiple use" they like. The suggestion that timber harvesting may destroy the possibilities of real multiple use is rarely considered.

The North American interpretation of "multi-purpose" has been to allocate areas of the forest to various groups for their activities - timber production here, fishing there, other recreational activities somewhere else. The public was satisfied until the needs or activities of one group started to impinge on the boundaries of another, e.g. overflowing parks, commercial versus sport fishing and "Don't Bite Our Donut". Such a narrow interpretation cannot be sustained for long. It encourages each group to be self-indulgent, concerned only with its own activities

in the forest. At the same time, it often considers other users as hostile, even "enemies". It is not only the timber production industry that will have to adjust its thinking.

The current position of the government, acting as an observer only, is untenable and will have to change. The government will have to assume the responsibility that is rightfully theirs.

The second Five Year FMAs Review of 1987 suggests that this has not happened yet. One wonders if even the OMNR has an understanding of what "multiple use" really entails. An excellent example of their naivete is found in one of the FMA's audit. There is a sentence by the auditors praising the forestry staff of the FMA holder.

It is put this way:

The personal involvement of company forestry staff in extensive outdoor recreation pursuits has done much to promote integrated resource management practices on the Unit. (OMNR, 1987)

If this is to be taken at face value as an example of the implementation of a "multiple use" policy, than one would have reason to question the credibility of the whole Audit. Even the local press had a good laugh on reading that sentence.

There is no doubt in my mind that the present aim of forest activities in the boreal forest is primarily the production of wood fibre. Presumably this is to be achieved in the most "efficient", most "economical" manner. At the same time, MNR and industry are waving the banner of "multiple use forestry". At the field level multiple use forestry entails the application of different techniques for harvesting and siliviculture. So far this concept of "multiple use" has not been successful because it is poorly understood. There has been a lack of ethical commitment, a lack of background information and a lack of genuine testing. "Multiple use" frequently means different things to different people. I have heard comments to the effect that:

We are opening the bush by roads for hunters, we are not objecting to the public using them.

We are leaving standing timber in reserves along the lakes, and so losing prime timber.

We are applying prescriptions dictated by the MNR in their Guidelines. We should be compensated for timber being lost from production.

Large, contiguous, clearcutting is good for moose because it duplicates nature.

Baskerville labelled the present approach as expressed in different MNR guidelines as "unsatisfactory" and "restrictive." "Using constraints is the opposite of management." (Exhibit 972, p. 4)

In contrast, Baskerville testified that:

the intent of management is to control the temporal/spatial pattern in a forest so as to regulate availability of certain stand conditions. (Exhibit 970, p. 15)

To achieve this, Baskerville recommends a new technology transfer, backed up by modelling, forecasting, targetting, analysing, etc., is needed. The question to ask here is this - if one does not restrict the "normal operations" as presently practised and preferred by industry in the forest, how does one "create the patterns in the forests" which will suit the diverse demands of timber and wild life? Baskerville is correct when he says that provisions for wildlife (and other uses) have to be made. The necessary "patterns in the forests" should be set through ground rules and prescriptions in the TMPs, starting with harvesting methods. Such techniques are by necessity restrictive because consideration must be, and is, given to other uses. These "constraints" may be extremely complex in their proper application, especially when compared with the simplistic measures to which we are accustomed.

It is obvious that from a multi-purpose forest maximization of a certain benefit, e.g. wood, cannot be demanded, because in this way other benefits will fade. Therefore an optimization of benefits from the forest is required. (Mlinsek, 1984)

Genuine understanding of and compliance with this restrictive approach is contrary to the mind-set of most personnel in industry and the OMNR. The terms are bandied about with much fanfare and used freely as long as operations can proceed normally.

For many years I was trying in an individual effort to create these "patterns in the forest". The prescriptions used were a combination of cut modification (small area clearcut management) and artificial reforestation of old cutovers. The results demonstrated clearly the benefits of holistic management in accommodating timber production along with wildlife considerations. The lessons from this have been convincing but unfortunately, have received little acceptance.

8.5 Integration of Logging with Silviculture

It has been pointed out many times that one of the benefits of FMAs is the "integration of logging with silviculture". To achieve this, funding, stock production, stock delivery and silvicultural treatments must all work in tandem. Unfortunately, there are many delays between harvesting and actual renewal. For example, planting may not take place until 2 - 3 years after harvesting.

In addition to the problem of low ground harvesting, the magnitude of the regeneration program under the

Forest Management Agreement created logistic problems for achieving the regeneration targets dictated by the allowable cut. (OMNR, 1987)

Much has been said about the "integration of logging with silviculture". This can best be achieved through a single agency being responsible for both. The main benefit is the direct flow from planning to implementation.

The advantage of FMA's and this "integration" is that it gave industry the freedom to act on their own without dealing with the government bureaucracy and, at the same time, to use their highly advertised "efficiencies".

Strip cutting involves extra planning and demands a closer touch with the area being regenerated.
(Jeglum, 1989)

There is no doubt that some additional effort is necessary initially when using small area clearcut management. After all, what is more simple and more traditional than cutting the forest down by square miles and leaving the rest to nature?

The educational system in forestry does not place much emphasis on non-traditional harvesting and silvicultural techniques and methods. It is no wonder, then, that graduates are poorly equipped to use prescriptions other than the norm. More complex systems do not fit into industrial strategies which respond to today's market

forces only.

Added to the above is the fact that foresters seldom go to the forest, for a variety of reasons. This, combined with frequent movements of OMNR staff, means that decisions are often being made by professionals with very little "hands-on" knowledge or experience with the eco systems they are currently managing.

Bush foremen must understand the need to treat different sites with different harvesting methods.
(Morrow, 1989)

However, bush foremen can only implement harvesting and silvicultural prescriptions from a proper timber management planning process. These prescriptions must be developed by a forest manager who is primarily responsible for the process.

It should be clear by now that "integration of logging with silviculture" cannot be imposed or legislated. It will be implemented only when it is fully understood and accepted as a WHOLE. This will happen only when the education permits and necessity dictates.

Clear-cut loggers worldwide fail as partial-cut loggers, at least initially. It takes time and patience to develop partial-cut loggers with an ethic for the residual forest. It can be done however, as it has been done elsewhere in the world. On the other hand, in those places wood has been more valuable per unit than here. Have our values increased enough so we can afford to move into this type of logging? (Beck, 1988)

8.6 Intensification of Timber Production

The concept of the "intensification of forestry" in Ontario is one which is strongly advocated in the FMAs. It is mirrored by the use of tree planting and other artificial means as THE answer to reforestation.

In forestry the financial investment in failure is compounded by the length of time that elapses before these failures become obvious. The problems with intensification of timber production in the boreal forest are further complicated by our lack of knowledge of the forest land itself. The quality of sites cannot be accurately estimated on all cutover areas.

It should be obvious that in the rush for acceptance and implementation of FMAs, the government bureaucracy failed to take into consideration the following.

It is logical that the effectiveness of silvicultural methods -- including tree planting -- is greatest when the silvicultural influences and regulating processes inherent in the forest itself are working in the direction where the forest produces the maximum soil fertility obtainable on a site by its own activity, maintains this fertility, ensures self-regeneration and fulfills its timber production and social benefits function to a nearly optimum degree. Even a minimum of silvicultural expertise will produce the maximum possible overall success.
(Leibundgut, 1969)

One should always pay attention to the fact that:

Any effective approach to silviculture must increasingly get away from the notion that what is required is to keep the treadmill going with a minimum of mental effort, from planting trees to cutting them and back to planting again, based on conventional farming methods. Rather, it is the function of effective silviculture to use natural processes and technical means additively and with maximum effectiveness in achieving the overall aims of forest policy. (Leibundgut, 1969)

Finally, it bears repeating that forests should, and indeed must, fulfill multiple use and environmental functions. This was true in the past and it is increasingly more important today. If forest managers, industrial or government, and politicians fail to grasp this truth, somebody else will, and will grab the right to act on it.

Forest regeneration today has the characteristics of playing Russian roulette -- trial and error -- where the forester invests in advanced techniques and nature capriciously countermoves with insects, diseases, frost, frost heaving and competition. It is, of course, not possible to master the situation with only technical solutions. Therefore, a thorough and comprehensive forest biological perspective is needed that optimizes the adaptation of silvicultural methods to the site's inherent, natural ability of production. (Jan-Erik Lundmark, 1979)

9. PROBLEMS OF INSTABILITY IN SECOND GROWTH AND OLD VIRGIN TIMBER

Rather than trying to address the future of a single boreal forest one must realize that there are two

distinctly different forests -- the old, virgin forest and the new, second growth forest. Each is unique in its origin, dynamics and design. Each has different problems and a different "stability".

The old forest was usually rejuvenated by fire and some has not been harvested as yet. The new forest is the product of harvesting. Some of it has been the beneficiary of silvicultural treatments, most of it has not.

In 1972, the Ontario Government approved the Forest production Policy which arbitrarily separated the forest into the two components using the year 1972 as the dividing line. This meant that any and all areas cut prior to 1972 were included in the "old forest" and are treated as virgin timber.

The knowledge of the dynamics of the virgin forest has been documented in Plonski's Yield Tables, F.R.I. and F.E.C. In contrast, the knowledge of the second growth stands is minimal, poorly documented and subject to much speculation. The future of these stands which encompass many millions of hectares and constitute our future wood supply, is uncertain. The main reason for this uncertainty is their "instability".

The old virgin forests are losing their stability because of their age and such external perturbations as wind, snow, insects, diseases and fire. These are direct consequences of the aging process. How much of the remaining virgin timber will be harvested and with what yield is uncertain. It will depend to a large degree on accessibility, economics, losses to fire and insects, degree of salvage, etc. Wildfire is one aspect which must be considered very seriously.

MNR policy requires a "new" or regenerated forest, producing an annual volume of 9.1 million cunits by the year 2020. (Exhibit 135)

Included in this total is the volume of second growth forest prior to 1972. What is excluded are recent cutovers and other areas not yet "free to grow". The stability of this second growth forest is uncertain and difficult to predict with confidence. Potential problems are often ignored, glossed over or simplified. For instance, the Minister of Natural Resources, Vince Kerrio, described the second growth forest as follows: "The established new forest is a diverse one in terms of tree species". (Hansard, 1989). A previous minister expressed it in other words:

I can guarantee you the number of trees, I cannot guarantee their size. (A. Pope, personal communication)

In both comments the primary species and stand quality are inconsequential and demonstrate the vagueness with which the problem of wood supply and its quality have been approached by politicians.

In the Lake Nipigon area we examined and assessed this problem by initiating a two-year study culminating in a report entitled, "St. Lawrence Licence Cutover Assessment", by E. Clemmer and T. Atkins, 1979 (unpublished). In this study, 500 cutover plots were examined, some of the second growth stands were up to 40 years old, and an estimate of future cutover yields was made. The report states:

Logging has brought a significant shift in the working group balance to favour the balsam fir, mixed wood, and hardwood working groups at the expense of the spruce and jack pine working groups by a factor of almost two to one. Finally, future cutover yields are projected to be poor at best for the spruce and jack pine working groups.

Since the time of that study there has been a further shift from softwoods to hardwoods, mainly due to the growth of aspen and the decline of balsam fir. This shift tends to occur in later stages of stand development (age 20-40), as a result of progressive changes in the stand

environment. The advanced growth of balsam fir establishes itself well initially but after 20 years +, it is attacked by spruce budworm and/or dominated by invading aspen. The quality of this second growth aspen is unknown at this time.

The modification of the physical environment by the plant community is the driving force behind species succession.

Succession, thus conceived, is the consequence of internal stress and its release and replacement of species is predictable.

Silvicultural evaluation of forest stability must therefore stress the primary importance of ecological aspects.

Perturbations must be met properly by silvicultural treatments putting them to maximal use. (Van Miegroet, 1980)

In plantations, repeated, often expensive silvicultural treatments must be carried out to obtain a new forest of primary species. The timing of these treatments is of the utmost importance as is the monitoring of stand conditions. Species such as aspen and balsam fir will play a disruptive role, vis-a-vis primary species, especially in large cutovers. This is inevitable whether cutovers are treated or not.

Many cutovers have been left to develop on their own. There the advance growth of balsam fir was considered a

good, cheap wood supply for the future. The pathological rotation of balsam fir with the help of the spruce budworm has proven many foresters wrong. We should remind ourselves of this when choosing treatments for plantations.

The choice of time and space must be completed by selective interventions at any moment but especially during the early phases of stand establishment and formation. The relation between species and individuals must be regulated continually. (Van Miegroet, 1980)

10. CONCLUSION

Finally, the creation of a new, healthy forest in boreal regions will be accomplished only if a combination of natural and artificial means of forest renewal is practised. The ratio between these two will depend on species sites and conditions of the stands. In the past, we have had ample opportunity to see the results of large area clearcut management. Such a prescription is usually the first perturbation creating instability for certain tree species, particularly the spruces. Spruces often do not have the ability to revert the site to its original conditions, or they may take a long time to do so.

There is room for the intensification of timber management but not at the cost of forest stability and ecosystem

productivity. This is a real challenge for the intensification of timber production in the boreal forest.

To the experienced observer it is more than obvious that regeneration decisions in the boreal forest are dictated by harvesting decisions. To rationalize this situation and declare it as being within the confines of "the integration of logging with silviculture", "normal operations" are considered to be complementary to forest renewal and thus serve it well. There are many who would and do dispute this.

Even from strictly a timber production point of view, the ecosystem should dictate harvesting and silvicultural prescriptions. Most of today's foresters have too little idea about the dynamics and complexities of the forest with which they are entrusted. Added to this, they are trying to "renew" the sources of many other "products" (fish and wildlife, aesthetics, tourism, etc.) which may compete with each other. They have been poorly prepared for these roles.

My investigations lead me to conclude the following:

1. Wildfire in standing timber has beneficial effects on the ecology of black spruce sites, their regeneration and ability to promote continuous productivity. These effects are not duplicated by large area clearcutting.

2. There is a necessity to improve the Forest Eco-system Classification documents to consider disturbed sites and to provide better and more practical guidelines for field forest managers.
3. Pre-cut and post-cut surveys should be done by experienced foresters and forest technicians to prevent duplication and repetition of mistakes.
4. The problem of trembling aspen as competition and its effects on the establishment of primary species must be acknowledged. This problem could be minimized by changes to harvest practices and the use of biologically-oriented silvicultural prescriptions.
5. Tree planting should be reserved for specific sites only. Frequently the sites close to roads that are suitable for planting suffer heavy damage from logging equipment. "Normal operations" are frequently conducted without consideration of site protection. Subsequent renewal efforts therefore suffer.
6. Better and more site-specific site preparation of cutovers must be practised with a strong emphasis on biological stability.

7. There is a need to emphasize specific site protection. Small area clearcut management which answers this need should replace present harvesting strategies. This is possibly the best way to address the problems specific to many uplands and lowlands in the boreal forest.
8. The term "fragile sites" must be accepted and understood and their vulnerability considered by loggers. These sites represent a large proportion of the productive forest land base.
9. The separation of logging and silviculture still exists on most if not all logging operations. This means that the logger uses the cheapest, most convenient method of extraction and the resulting problems for renewal cannot be resolved by simply planting trees.
10. The "second growth forest," the lack of knowledge of its dynamics, and its instability, constitute potential serious problems for long-term wood supply in Ontario.
11. The interpretation of "multiple use" by the logging industry has evolved into "sequential use". After timber has been harvested and sites regenerated (or abandoned), other users can indulge in all the "multiple use" they

like. The suggestion that timber harvesting may destroy the possibilities of real "multiple use" is rarely considered.

REFERENCES - WITNESS STATEMENT No. 3

- Baskerville, L. Gordon. In press. Address to the Natural Regeneration Conference. (School of Forestry, University of New Brunswick, September 1989)
- Baskerville, L. Gordon. An Audit of Management of the Crown Forests of Ontario. (1986), 97 pp., Exhibit 16.
- Beck, J.A. Symposium summary in Management and Utilization of Mixed Wood, J.K. Samoil (ed). (Northern Forestry Centre, Canadian Forest Service, Information Report NOR-X-296, 1988), pp. 145-146.
- Bella, J.E. Quoted in Risk Management in Forest Planning. (Canada-Alberta Forest Resource Development Agreement. W.R. Dempster and Associates Ltd., 1988), p. 29.
- Brand, D.G. Managing for successful reforestation programs. (CPPA Woodlands, Canadian Forest Industries, March, 1989)
- Burringh, P. "Bioproductivity and Land Potential" in Biomass: Regenerable Energy. D.O. Hall and R.P. Overend (eds). (John Wiley and Sons, 1987), pp. 27-46.
- Canadian Pulp and Paper Association. Harvesting the Forest Crop. (Pamphlet, July 1989)
- Canadian Pulp and Paper Association. From Watershed to Watermark. (1980), 28 pp.
- Chapman, H. "Plans for Development of Forests" in Forest Management (The Hildreth Press Publishers, Bristol, Conn., 1950), ch. 14, pp. 187-197.
- Clemmer, E. and T. Atkins. St. Lawrence Licence Cut-Over Assessment, Final Report. (Ontario Ministry of Natural Resources. Internal Report, 1979), 49 pp.
- Clemmer, E. On the processes regulating the growth of black spruce stands in North Western Ontario. (Master thesis, 1977), 100 pp., available for examination at CELA.
- Corbett, P.M. Aspects of Site Preparation, Biology and Practice. (Proceedings of a Workshop, OMNR, Fort Frances, Ontario, Sept. 27-28, 1988), 101 pp.
- Fleming, R.L. and R. Crossfield. Strip Cutting in Shallow Soil Upland Black Spruce Near Nipigon, Ontario. III. Windfall and Mortality in the Leave Strips: Preliminary Results. (Department of the Environment, Canadian Forestry Service, Sault Ste. Marie, 1983) Internal Report 0-X-354, 27 pp. and appendix.

- Gordon, A. Seasonal Patterns of Nitrogen Mineralization and Nitrification following Harvesting in the White Spruce Forests of Interior Alaska. (Unpublished doctoral thesis, Fairbanks, Alaska, 1986)
- Gorham, E. The Development of Peatlands. (Quarterly Review of Biology, 1957), 32: 145-164.
- Haavisto, V.F., A. Groot, and J.K. Jeglum. "Climate, Water and Drainage in Peatlands" in Climate Applications in Forest Renewal and Forest Production. D.C. MacIver, R.B. Street, and A.N. Auclair eds. (Proceedings of Forest Climate, 1989)
- Haavisto, V.F. (1989) Personal Communication.
- Hansard Official Report of Debates. Legislative Assembly of Ontario, Standing Committee on Resource Development. (1st session, 34th Parliament, November 23, 1988), pp. 422-425.
- Hesselman, Henrik. Dependency of humus on age and dynamics of spruce stands (Vaccinium type) and about the influence of humus on regeneration and growth of the forest. (Stockholm, 1937), No. 30, pp. 529-669. Not available in English.
- Jeglum, J.K. Alternate-strip Clearcutting to Regenerate Black Spruce: Why Aren't We Using it More? in Proceedings Workshop "Tools for Site Specific Silviculture in Northwestern Ontario" (April 18-20, 1989, Thunder Bay Ontario OMNR Technical Development Unit), 19 pp.
- Ketcheson, D.A. The Impact of Strip Cutting on Logging Costs; Additional Road Construction and Maintenance Are the Key Factors which Incur Extra Costs. (Pulp and Paper Magazine of Canada, 1982), 83(7): 29-34.
- Kimmins, J.P. Sustained Yield, Timber Mining, and the Concept of Ecological Rotation: a British Columbian View. (Forestry Chronicle, 1974), 50: 27-31.
- Leibundgut, H. Effective silviculture and landscape management. (Der Forst und Holzwirt, 1969), 24: 409-414. Translation.
- Losee, S.T.B. Strip Group Cutting in Black Spruce at the Abitibi Woodland's Laboratory. (Pulp and Paper Magazine of Canada, June 1966)
- Lundmark, J.E. Scarification in general and in particular within cold climate sites. (1970), 9 pp. Translation.

- Lynn, R. Quality of Black Spruce, Geraldton District. (Lands and Forests, 1962) Unpublished report, not available.
- Marek, G.T. Evaluation of Three Silvicultural Treatments in the North Central Region. (1983)
- Marek, G.T. and R.D. Fry. Alternate Strip-Cutting in Black Spruce. (Department of Lands and Forests, 1964) Unpublished report, not available.
- MacLean, D.A., S.J. Woodley, M.G. Weber, and R.N. Wein. "Fire and Nutrient Cycling" in The Role of Fire in Northern Circumpolar Ecosystems. R. Wein, R.R. Riewe, and I.R. Methven eds. (Wiley, N.Y., 1983), chapter 7, pp. 111-132.
- McColm, R.G. Post Cut classification of recent cut-over 1978-82. (Abitibi-Price Inc., Smooth Rock Falls License, 1983) OMNR unpublished report.
- Methven, I.R., C.E. Van Wagner, and B.J. Stocks. The Vegetation of Four Burned Areas in Northwestern Ontario. (Environment Canada, Forestry Service, 1975), Information Report PS-X-60.
- Mlinsek, D. Development and Technology Transfer in Forestry. (International Forest Congress, Quebec City, IUFRO, 1984), pp. 55-58.
- Morrow, L. (1979) Quoted in G.K.M. Smith Alternate Strip Clearcutting of Upland Black Spruce. (Canadian Forest Industries, March 1989), pp. 10-16.
- Oke, T.R. Boundary layer climates. (Methuen, London, 1978), 372 pp. Available at U of T, QC 981.7 M5 O54 Sigsam.
- Ontario Ministry of Natural Resources. Forest Management Agreements, 2nd Five Year Review, 1981-1986. (Toronto, 1987), 93 pp. Exhibit 31.
- Ontario Ministry of Natural Resources. Canadian Pacific Forest Products/Great Lakes Timber Management Plan. (Nipigon, Ontario, 1987) p. 74.
- Pope, A. Personal Communication (1989)
- Rennie, P.J. "The uptake of nutrients by timber forest, and its importance to timber production in Britain." (Quarterly Journal of Forestry, 1957), 51: 101-115.

- Smith, D.M. The Practice of Silviculture. Part III: Silvicultural Systems. (John Wiley and Sons, New York, 1962), pp. 327-08. Available at U of T, SD 391 S59 E Sci.
- Smith, G.K.M. Alternate Strip Clearcutting of Upland Black Spruce. (Canadian Forest Industries, March 1989), pp. 10-16.
- Stolina, M. Resistance Potential of Forest Stands and Spruce Ecosystems. (Proceedings, Stability of Spruce Forest Ecosystems, Brno, Czechoslovakia, IUFRO/MAB, 1979), pp. 75-88.
- Sutton, R.F. Silvicultural Prescription for Stand Establishment: Biological Considerations. (Great Lakes Forestry Centre, Sault Ste Marie, 1990)
- Thomas, P.A. and R.W. Wein. "Post fire establishment of jack pine and black spruce from seed on organic soil seedbeds". In: Resources and Dynamics of the Boreal Zone. R.W. Wein, R.Riewe, and I.R. Methven eds. (Proceedings of a conference, Thunder Bay, Ontario, 1983) pp. 281-294.
- Timmer, V.R., H.M. Savinsky, and G.T. Marek. Impact of intensive harvesting on nutrient budgets of boreal forest stands. In: Resources and Dynamics of the Boreal Zone. R.W. Wein, R. Riewe, and I.R. Methven eds. (Proceedings of a conference, Thunder Bay, Ontario, 1983), pp. 131-147. Attached to Panel 10, Volume I, pp. 451-467.
- Van Miegroet, M. The Basic Concept of Forest Stability. (Proceedings of the Symposium: Stability of Spruce Forest Ecosystems, Brno, Czechoslovakia, IUFRO/MAB, 1979), pp. 17-46.
- Vincent, A.B. Studies of Deteriorating Peatland Area in the Ontario Claybelt. (Department of Forestry, Ontario Region, Forest Research Laboratory, Maple, Ontario, 1965), 28 pp.
- Walters. "A Leap in the Right Direction". (Address given at the Ontario Conference on Forest Regeneration, OMNR, Thunder Bay, March 29-31, 1978), pp. 81-85.
- Weetman, G.F. and B. Weber. The Influence of Wood Harvesting on the Nutrient Status of Two Spruce Stands. (Canadian Journal of Forest Research, 1972), 2: 351-369. Exhibit 422.
- Zinkan, C.G., J.K. Jeglum, and D.E. Harvey. Oxygen in Water Culture Influences Growth and Nutrient Uptake of Jack Pine, Black Spruce and White Spruce Seedlings. (Canadian Journal of Plant Science, 1974), 54: 553-558.

CAZONEA 87W03

Ontario. Environmental Assessment Board.

Witness Statement No.3

ECOLOGICAL AND TIMBER MANAGEMENT ISSUES RELATING T

1987

**RESOURCE CENTRE
INST. FOR ENVIRON'L. STUDIES
UNIVERSITY OF TORONTO**



